What is claimed is:

1. A method for making a structured screen that provides a desired spread of incident light, said structured screen comprising a substrate and a plurality of microstructures distributed over at least one surface of said substrate, said method comprising:
   (a) selecting a location on said at least one surface of the substrate for each of said plurality of microstructures;
   (b) selecting a configuration for each of said plurality of microstructures;
   (c) calculating the spread of the incident light for the selected locations and the selected configurations of steps (a) and (b);
   (d) comparing the calculated spread of step (c) with the desired spread and, if necessary, repeating at least one of steps (a) and (b), and step (c) until the comparison between the calculated spread and desired spread satisfies a specified criterion; and
   (e) producing a plurality of microstructures having, to an accuracy of better than $10 \bullet \lambda_n$, the locations and the configurations which, in step (d), resulted in the satisfaction of the specified criterion, where λ_n is the nominal operating wavelength for the screen.
2. The method of Claim 1 wherein the locations selected in step (a) form a regular array.
3. The method of Claim 2 wherein the array is a hexagonal array.
4. The method of Claim 1 wherein the locations selected in step (a) are based on a set of unit cells which form a mosaic.
5. The method of Claim 4 wherein the mosaic is random.
6. The method of Claim 4 wherein the structured screen has internal microstructures and edge microstructures and the mosaic provides at least some junctions between internal microstructures that correspond, in terms of light spreading, to at least some junctions

between edge microstructures resulting from the tiling of two structured screens to one another.

7. The method of Claim 1 wherein at least some of the locations selected in step (a) are randomly distributed in accordance with a predetermined probability density function.

8. The method of Claim 1 wherein the locations of the microstructures are based on a random set of polygonal shaped boundaries.

9. The method of Claim 1 wherein in step (b) at least a portion of at least some of the microstructures is selected to have a configuration given by:

$$s(x,y)=\frac{c\left[(x-x_c)^2+(y-y_c)^2\right]}{1+\sqrt{1-(\kappa+1)c^2\left[(x-x_c)^2+(y-y_c)^2\right]}}+\sum_p A_p\left[(x-x_c)^2+(y-y_c)^2\right]^{p/2}$$

where s(x,y) is the sag of said portion, c is its curvature, (x_c, y_c) is its center point, κ is a conic constant, and A_p are aspheric coefficients.

10. The method of Claim 9 wherein $A_p \neq 0$ for at least one p.

11. The method of Claim 9 wherein $\kappa \neq 0$.

12. The method of Claim 9 wherein:

    κ = −1; and

    $A_p = 0$ for all p.

13. The method of Claim 1 wherein in step (b) at least a portion of at least some of the microstructures is selected to have a configuration given by:

$$s(x,y)=\sum_{p=1}^{\infty} B_p(x-x_c)^p+C_p(y-y_c)^p$$

where s(x,y) is the sag of said portion, (x_c, y_c) is its center point, and B_p and C_p are power series coefficients.

14. The method of Claim 1 wherein at least some of the microstructures comprise (i) a curved, microlens portion and (ii) a straight-sided, piston portion.

15. The method of Claim 1 wherein at least some of the microstructures comprise an anamorphic microlens.

16. The method of Claim 1 wherein in step (b) at least a portion of at least some of the microstructures is selected to have a configuration given by:

$$s(x,y)=\frac{c_x(x-x_c)^2+c_y(y-y_c)^2}{1+\sqrt{1-(1+\kappa_x)c_x(x-x_c)^2+(1+\kappa_y)c_y(y-y_c)^2}}$$

where s(x,y) is the sag of said portion, (x_c, y_c) is its center point, c_x and c_y are curvatures along x and y, respectively, and κ_x and κ_y are conic constants along x and y, respectively.

17. The method of Claim 1 wherein in step (b) at least a portion of at least some of the microstructures is selected to have a configuration given by:

$$s(x,y)=\frac{c_x(x-x_c)^2}{1+\sqrt{1-(1+\kappa_x)(x-x_c)^2}}+\frac{c_y(y-y_c)^2}{1+\sqrt{1-(1+\kappa_y)(y-y_c)^2}}+\sum_p A_{xp}(x-x_c)^p+A_{yp}(y-y_c)^p$$

where s(x,y) is the sag of said portion, (x_c, y_c) is its center point, c_x and c_y are curvatures along x and y, respectively, κ_x and κ_y are conic constants along x and y, respectively, and A_{xp} and A_{yp} are aspheric coefficients along x and y, respectively.

18. The method of Claim 1 wherein:

(a) at least a portion of at least some of the microstructures is selected to have a configuration characterized by at least one parameter; and

(b) said at least one parameter is randomly distributed in accordance with a predetermined probability density function.

19. The method of Claim 18 wherein the at least one randomly distributed parameter has a uniform probability density function over a predetermined range for the parameter.

20. The method of Claim 18 wherein the at least one randomly distributed parameter is radius of curvature.

21. The method of Claim 18 wherein the at least one randomly distributed parameter is maximum surface sag.

22. The method of Claim 18 wherein the at least one randomly distributed parameter is characteristic of the transverse size of a microstructure.

23. The method of Claim 22 wherein the parameter is diameter.

24. The method of Claim 1 wherein:

(a) at least some of the microstructures comprise (i) a curved, microlens portion and (ii) a straight-sided, piston portion; and

(b) the heights of the straight-sided, piston portions are randomly distributed in accordance with a predetermined probability density function.

25. The method of Claim 24 wherein the heights of the straight-sided, piston portions have a uniform probability density function over a predetermined range for said heights.

26. The method of Claim 1 wherein:

(a) at least some of the microstructures have an apex, said apex being separated from the substrate by a distance; and

(b) at least some of said distances are randomly distributed in accordance with a predetermined probability density function.

27. The method of Claim 26 wherein said randomly distributed distances have a maximum value and the difference between said maximum value and said randomly distributed distances has a uniform

probability density function over a predetermined range for said difference.

28. The method of Claim 1 wherein the substrate defines a first optical axis and the configuration of at least some of the microstructures comprises a microlens which defines a second optical axis which is not parallel to the first optical axis.

29. The method of Claim 1 wherein as produced in step (e), the plurality of microstructures have, to an accuracy of better than $5 \bullet \lambda_n$, the locations and the configurations which, in step (d), resulted in the satisfaction of the specified criterion.

30. The method of Claim 1 wherein step (e) comprises direct laser writing in a photoresist.

31. The method of Claim 1 wherein microstructures are distributed over two of the substrate's surfaces.

32. Apparatus for controlled spreading of light comprising a plurality of microstructures, each microstructure being located with better than $10 \bullet \lambda_n$ accuracy at a predetermined location with respect to all other microstructures and each microstructure having a configuration that corresponds, with better than $10 \bullet \lambda_n$ accuracy, to a predetermined mathematical relation, where λ_n is the nominal operating wavelength of the apparatus and said predetermined locations and predetermined mathematical relations allow an a priori calculation of the spreading of incident light by the apparatus.

33. The apparatus of Claim 32 wherein the predetermined locations form a regular array.

34. The apparatus of Claim 33 wherein the array is a hexagonal array.

35. The apparatus of Claim 32 wherein the predetermined locations are based on a set of unit cells which form a mosaic.

36. The apparatus of Claim 35 wherein the mosaic is random.

37. The apparatus of Claim 35 wherein the apparatus has internal microstructures and edge microstructures and the mosaic provides at

least some junctions between internal microstructures that correspond, in terms of light spreading, to at least some junctions between edge microstructures resulting from the tiling of two samples of the apparatus to one another.

38. The apparatus of Claim 32 wherein at least some of the predetermined locations are randomly distributed in accordance with a predetermined probability density function.

39. The apparatus of Claim 32 wherein the predetermined locations are based on a random set of polygonal shaped boundaries.

40. The apparatus of Claim 32 wherein at least a portion of the configuration of at least some of the microstructures corresponds with better than $10 \bullet \lambda_n$ accuracy to the mathematical relation:

$$s(x,y) = \frac{c\left[(x-x_c)^2+(y-y_c)^2\right]}{1+\sqrt{1-(\kappa+1)c^2\left[(x-x_c)^2+(y-y_c)^2\right]}} + \sum_p A_p\left[(x-x_c)^2+(y-y_c)^2\right]^{p/2}$$

where s(x,y) is the sag of said portion, c is its curvature, (x_c, y_c) is its center point, κ is a conic constant, and A_p are aspheric coefficients.

41. The apparatus of Claim 40 wherein $A_p \neq 0$ for at least one p.

42. The apparatus of Claim 40 wherein $\kappa \neq 0$.

43. The apparatus of Claim 40 wherein:

(a) $\kappa = -1$; and

(b) $A_p = 0$ for all p.

44. The apparatus of Claim 32 wherein at least a portion of the configuration of at least some of the microstructures corresponds with better than $10 \bullet \lambda_n$ accuracy to the mathematical relation:

$$s(x,y) = \sum_{p=1}^{\infty} B_p(x-x_c)^p + C_p(y-y_c)^p$$

where s(x,y) is the sag of said portion, (x_c, y_c) is its center point, and B_p and C_p are power series coefficients.

45. The apparatus of Claim 32 wherein at least some of the microstructures comprise (i) a curved, microlens portion and (ii) a straight-sided, piston portion.

46. The apparatus of Claim 32 wherein at least some of the microstructures comprise an anamorphic microlens.

47. The apparatus of Claim 32 wherein at least a portion of the configuration of at least some of the microstructures corresponds with better than $10 \bullet \lambda_n$ accuracy to the mathematical relation:

$$s(x,y)=\frac{c_x(x-x_c)^2+c_y(y-y_c)^2}{1+\sqrt{1-(1+\kappa_x)c_x(x-x_c)^2+(1+\kappa_y)c_y(y-y_c)^2}}$$

where s(x,y) is the sag of said portion, (x_c, y_c) is its center point, c_x and c_y are curvatures along x and y, respectively, and κ_x and κ_y are conic constants along x and y, respectively.

48. The apparatus of Claim 32 wherein at least a portion of the configuration of at least some of the microstructures corresponds with better than $10 \bullet \lambda_n$ accuracy to the mathematical relation:

$$s(x,y)=\frac{c_x(x-x_c)^2}{1+\sqrt{1-(1+\kappa_x)(x-x_c)^2}}+\frac{c_y(y-y_c)^2}{1+\sqrt{1-(1+\kappa_y)(y-y_c)^2}}+\sum_p A_{xp}(x-x_c)^p+A_{yp}(y-y_c)^p$$

where s(x,y) is the sag of said portion, (x_c, y_c) is its center point, c_x and c_y are curvatures along x and y, respectively, κ_x and κ_y are conic constants along x and y, respectively, and A_{xp} and A_{yp} are aspheric coefficients along x and y, respectively.

49. The apparatus of Claim 32 wherein:

(a) at least some of the predetermined mathematical relations include at least one common parameter; and

(b) said at least one common parameter is randomly distributed in accordance with a predetermined probability density function.

50. The apparatus of Claim 49 wherein the at least one randomly distributed common parameter has a uniform probability density function over a predetermined range for said common parameter.

51. The apparatus of Claim 49 wherein the at least one randomly distributed common parameter is radius of curvature.

52. The apparatus of Claim 49 wherein the at least one randomly distributed common parameter is maximum surface sag.

53. The apparatus of Claim 49 wherein the at least one randomly distributed common parameter is a parameter characteristic of the transverse size of a microstructure.

54. The apparatus of Claim 53 wherein the parameter is diameter.

55. The apparatus of Claim 32 wherein:

(a) at least some of the microstructures comprise (i) a curved, microlens portion, and (ii) a straight-sided, piston portion; and

(b) the heights of the straight-sided, piston portions are randomly distributed in accordance with a predetermined probability density function.

56. The apparatus of Claim 55 wherein the heights of the straight-sided, piston portions have a uniform probability density function over a predetermined range for said heights.

57. The apparatus of Claim 32 wherein:

(a) at least some of the microstructures have an apex; and

(b) the heights of at least some of said apexes are randomly distributed in accordance with a predetermined probability density function.

58. The apparatus of Claim 57 wherein said randomly distributed heights have a maximum value and the difference between said

maximum value and said randomly distributed heights has a uniform probability density function over a predetermined range for said difference.

59. The apparatus of Claim 32 wherein the apparatus defines a first optical axis and the configuration of at least some of the microstructures comprises a microlens which defines a second optical axis which is not parallel to the first optical axis.

60. The apparatus of Claim 32 wherein each microstructure is located with better than $5 \bullet \lambda_n$ accuracy at a predetermined location with respect to all other microstructures and each microstructure has a configuration that with better than $5 \bullet \lambda_n$ accuracy corresponds to a predetermined mathematical relation.

61. The apparatus of Claim 32 wherein the apparatus comprises two spaced-apart surfaces and the plurality of microstructures is distributed over both said surfaces.

62. The apparatus of Claim 32 wherein:
    (a) the apparatus comprises two spaced-apart surfaces,
    (b) the plurality of microstructures is distributed over one of said surfaces; and
    (c) the other surface is a Fresnel lens.

63. A microstructure for use in an optical device comprising (i) a curved, microlens portion and (ii) a straight-sided, piston portion.

64. The microstructure of Claim 63 wherein the curved, microlens portion has a spherical shape.

65. The microstructure of Claim 63 wherein the curved, microlens portion has a parabolic shape.

66. Apparatus for controlled spreading of light comprising a plurality of microstructures wherein at least a portion of each microstructure is described by the equation:

$$s(x,y)=\frac{c\left[(x-x_c)^2+(y-y_c)^2\right]}{1+\sqrt{1-(\kappa+1)c^2\left[(x-x_c)^2+(y-y_c)^2\right]}}+\sum_p A_p\left[(x-x_c)^2+(y-y_c)^2\right]^{p/2}$$

where s(x,y) is the sag of said portion, c is a predetermined curvature, (x_c, y_c) is a predetermined center point, κ is a predetermined conic constant, A_p are predetermined aspheric coefficients, and at least κ or one of the A_p's is not equal to zero.

67. The apparatus of Claim 66 wherein:

(a) $\kappa = -1$; and

(b) $A_p = 0$ for all p.

68. Apparatus for controlled spreading of light comprising a plurality of microstructures wherein at least a portion of each microstructure is described by the equation:

$$s(x,y)=\frac{c_x(x-x_c)^2+c_y(y-y_c)^2}{1+\sqrt{1-(1+\kappa_x)c_x(x-x_c)^2+(1+\kappa_y)c_y(y-y_c)^2}}$$

where s(x,y) is the sag of said portion, (x_c, y_c) is a predetermined center point, c_x and c_y are predetermined, non-equal curvatures along x and y, respectively, and κ_x and κ_y are predetermined conic constants along x and y, respectively.

69. Apparatus for controlled spreading of light comprising a plurality of microstructures wherein at least a portion of each microstructure is described by the equation:

$$s(x,y)=\frac{c_x(x-x_c)^2}{1+\sqrt{1-(1+\kappa_x)(x-x_c)^2}}+\frac{c_y(y-y_c)^2}{1+\sqrt{1-(1+\kappa_y)(y-y_c)^2}}+\sum_p A_{xp}(x-x_c)^p+A_{yp}(y-y_c)^p$$

where s(x,y) is the sag of said portion, (x_c, y_c) is a predetermined center point, c_x and c_y are predetermined, non-equal curvatures along

x and y, respectively, κ_x and κ_y are predetermined conic constants along x and y, respectively, and A_{xp} and A_{yp} are predetermined aspheric coefficients along x and y, respectively.

70. Apparatus for controlled spreading of light comprising a plurality of microstructures, each microstructure having a configuration that is characterized by at least one predetermined parameter which is randomly distributed in accordance with a predetermined probability density function.

71. The apparatus of Claim 70 wherein the at least one randomly-distributed parameter has a uniform probability density function.

72. The apparatus of Claim 70 wherein:

(a) each microstructure comprises (i) a curved, microlens portion and (ii) a straight-sided, piston portion; and

(b) the randomly-distributed parameter characterizes the straight-sided, piston portion.

73. The apparatus of Claim 70 wherein each microstructure is characterized by two predetermined parameters, each of which is randomly distributed in accordance with a predetermined probability density function which may be the same or different for the two parameters.

74. The apparatus of Claim 73 wherein each of the randomly-distributed parameters has a uniform probability density function over a predetermined range for the parameter.

75. The apparatus of Claim 73 wherein:

(a) each microstructure comprises (i) a curved, microlens portion and (ii) a straight-sided, piston portion; and

(b) one of the two randomly-distributed parameters characterizes the curved, microlens portion and the other randomly-distributed parameter characterizes the straight-sided, piston portion.

76. The apparatus of Claim 70 wherein the locations of the microstructures is randomized in accordance with a predetermined probability density function.

77. A structured screen comprising a plurality of predetermined microstructures, wherein:
    (a) said microstructures comprise (i) a curved, microlens portion and (ii) a straight-sided, piston portion which has a predetermined height which can be zero:
    (b) said curved, microlens portions have predetermined diameters and predetermined maximum sags; and
    (c) for at least some of said microlenses, the sum of the predetermined maximum sag and the predetermined height is greater than the predetermined diameter.

78. The structured screen of Claim 77 wherein at least one of the predetermined diameters, the predetermined maximum sags, and the predetermined heights is randomly distributed in accordance with a predetermined probability density function.

79. The structured screen of Claim 78 wherein the predetermined diameters have a uniform probability density function over a predetermined range for said diameters.

80. The structured screen of Claim 78 wherein the predetermined maximum sags have a uniform probability density function over a predetermined range for said maximum sags.

81. The structured screen of Claim 78 wherein the predetermined heights have a uniform probability density function over a predetermined range for said heights.

82. A structured screen comprising a plurality of predetermined aspherical microlenses, wherein said microlenses:
    (a) have predetermined diameters and predetermined maximum sags; and

(b) produce a spread of incident light which has a flatter intensity distribution than that produced by a plurality of spherical microlenses having the same predetermined diameters and predetermined sags.

83. The structured screen of Claim 82 wherein at least one of the predetermined diameters and the predetermined maximum sags is randomly distributed in accordance with a predetermined probability density function.

84. The structured screen of Claim 83 wherein the predetermined diameters have a uniform probability density function over a predetermined range for said diameters.

85. The structured screen of Claim 83 wherein the predetermined maximum sags have a uniform probability density function over a predetermined range for said maximum sags.

86. The structured screen of Claim 82 wherein at least some of the microlenses are parabolic.

87. A structured screen which defines an optical axis and comprises a plurality of microstructures at least some of which comprise a microlens having an optical axis which is not parallel to the optical axis of the structured screen.

88. A structured screen comprising:

(a) a Fresnel lens which comprises a plurality of surfaces in the form of concentric rings; and

(b) a plurality of microstructures distributed over at least some of said plurality of surfaces, said plurality of microstructures serving to control the spread of light incident on the structured screen.

89. A structured screen comprising a plurality of unit cells and a plurality of microstructures, one microstructure associated with each unit cell, wherein the perimeters of the unit cells are non-regular polygons.

90. The structured screen of Claim 89 wherein the perimeters are defined by a predetermined probability density function.

91. A structured screen comprising a plurality of microstructures at least some of which comprise a microlens having a first curvature in a first direction and a second curvature in a second direction orthogonal to the first direction, at least one of said first and second curvatures being randomly distributed in accordance with a predetermined probability density function.

92. The structured screen of Claim 91 where both the first and second curvatures are randomly distributed in accordance with a predetermined probability density function which may be the same or different for the two curvatures.

93. A structured screen comprising:

(a) a first sub-screen comprising a plurality of internal microstructures and a plurality of edge microstructures, each microstructure being located at a predetermined location with respect to all other microstructures, said predetermined locations being based on a first set of unit cells which form a first mosaic;

(b) a second sub-screen comprising a plurality of internal microstructures and a plurality of edge microstructures, each microstructure being located at a predetermined location with respect to all other microstructures, said predetermined locations being based on a second set of unit cells which form a second mosaic;

wherein:

(i) the first and second sub-screens are tiled to one another, said tiling producing edge junctions between edge microstructures of the first sub-screen and edge microstructures of the second sub-screen; and

(ii) each of the first and second mosaics provides at least some internal junctions between internal microstructures that correspond, in terms of light spreading, to at least some of the edge junctions.

94. The structured screen of Claim 93 wherein each of the first and second mosaics is random.

95. The structured screen of Claim 93 wherein the first and second sub-screens are identical.